Space Weather Technical Forecast

Issued on Monday, 29 November 2021 at 00:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: No Significant Activity Expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Very Low, with all X-ray flare activity below C-class. There are three sunspot containing active regions on the Earth-facing disc. AR2898 Cso/Beta gradually simplified with its trailer and intermediate spots fading. AR2900 Dsi/Beta gradually increased in size, but also simplified a little in structure. Both of these regions are in the southwest disc. AR2901 Hsx/alpha in the northeast disc remained small and stable. There are a number of filaments on the disc and one was observed lifting from the southwest, but with no subsequent CME visible. There were no Earth-directed CMEs evident in available imagery.

Solar Wind / Geomagnetic Activity: A weak CME, which arrived on the previous day largely dominated conditions, with Earth moving through its weak magnetic cloud. The speed measured by DSCOVR at L1 was slightly elevated for a time at first, peaking near 420 km/s at 28/0445 UTC, before gradually easing to background levels of 350-380km/s. Density declined from above average levels of 20-30ppcc at first to near average levels by 28/1025 UTC, but has recently gradually increased again to be above average at 15-20 ppcc. The Interplanetary Magnetic Field (IMF) strength, Bt, declined from 17nT to 8-10nT by the end of the period. The north-south component of the field (Bz), had an initial brief negative (southward) peak of -16nT at 28/0130 UTC, but then become predominately positive (northward) peaking 15nT before gradually declining. However, a gradual rotation in the field then occurred, with a more extended period of southward pointed field from 28/1900 UTC peaking -8 nT. The phi angle remained negative throughout. Geomagnetic Activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at background levels. High energy electron flux (greater than 2 MeV) as observed by GOES-16 decreased from moderate to background levels. The associated 24-hour integrated fluence remained below the Active threshold (1e8 integrated pfu), on a decreasing trend, with 2.49e6 integrated pfu recorded at 29/0000 UTC

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be low or very low, with a chance of C-class flares, primarily from AR2900. There is a very slightly above background (5%) chance of M-class flares.

Solar Wind / Geomagnetic Activity: A CME from a filament eruption early on the 26 Nov has been assessed as likely missing, but with low confidence, giving a small chance of some impact at Earth late day 1 or day 2 (29th or 30th). There may also be weak additional enhancements from various coronal holes fast winds through the period. This includes though from CH22 or CH24 at first, and then also from CH25 or CH26 on day 3 (1st). Enhancement from CH27 is also possible by the end of day 4 (2nd). Geomagnetic activity is expected to mostly Quiet with Unsettled throughout, but with an ongoing chance Active intervals, and a very slight chance of G1/Minor Storms on all days.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels. The high energy electron flux (greater than 2 MeV) is

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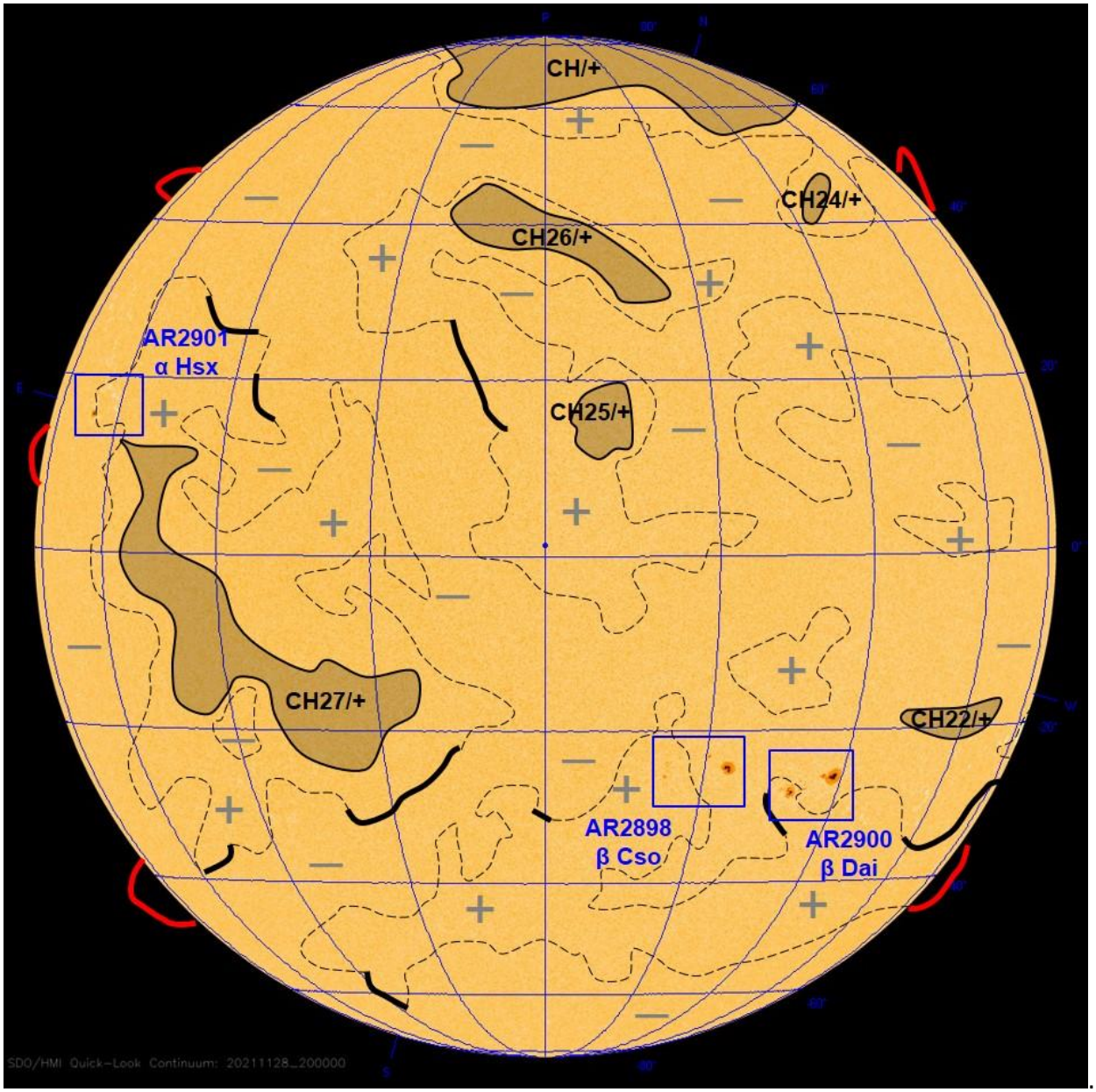
likely to be at background to moderate levels, with the next notable enhancement likely to be from the arrival of the fast winds from CH25 or CH26 on day 3 (1st). If this occurs, the fluence may rise as a result approaching the Active (1e8 integrated pfu) threshold, but is currently expected to remain below the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 28/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption was observed from the northeast disc around 26/0010 UTC, however analysis of any subsequent CME has been difficult due to limited good imagery. Whilst currently not expected, a glancing impact is possible, perhaps late day 1 (29th) or more likely day 2 (30th). There are no other Earth directed CMEs.

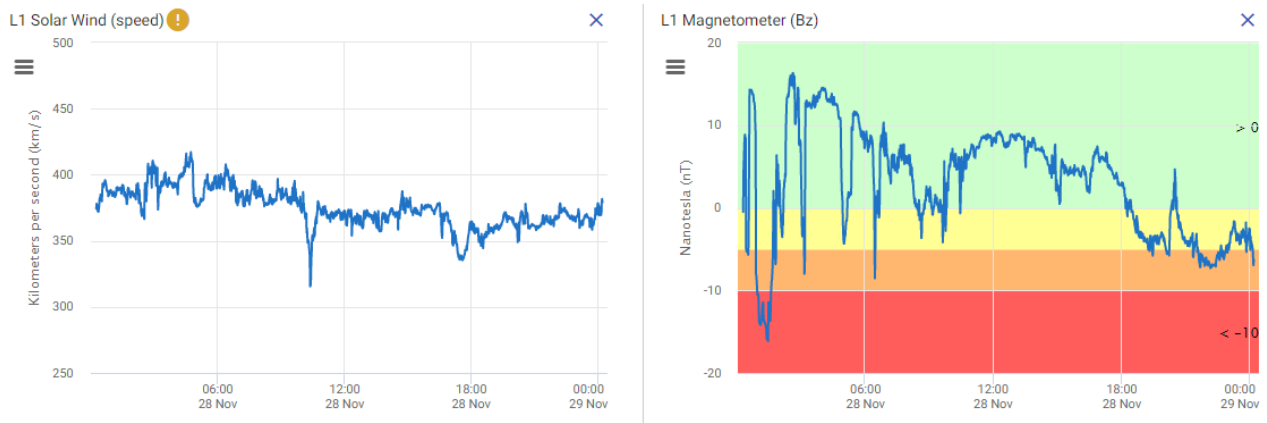
Solar winds speeds have remained at background with Earth not observing the associated fast winds from either of the small western disc coronal holes CH24 or CH22. Whilst density has recently increased alongside some southward pointing IMF, which could perhaps be indicative of an imminent connection to one of these weak features, it is likely that this is the tail end of a subsequent magnetic cloud from the CME arrival late on the 27th. A connection to either of these holes is still possible however. Further coronal hole enhancements are then possible day 3 (1st), from either CH25 or CH26, with an enhancement to the IMF observed on STEREO A during the 28th, corresponding to a likely day 3 arrival.

Finally, CH27, whilst located in the western hemisphere appears to be a notable feature, and whilst its fast wind is not expected to arrive until day 5 (3rd), there is the potential for a very fast solar wind (near 700 km/s, which has been observed from some coronal holes in the southern disc during the last month) to arrive by the end of day 4 (2nd).

Consequently geomagnetic activity is expected to mostly Quiet with Unsettled throughout, but there will be an ongoing chance of Active intervals, with a very slight chance of G1/Minor Storms on all days due to the chance of coronal hole fast wind or CME arrivals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Solar wind speeds and associated Bz value, showing clear CME enhancement.



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Radio Blackouts - X-Ray Flares:

There are now three sunspot containing active regions on the Earth-facing disc. AR2898 (Cso/Beta) and AR2900 (Dsi/Beta) are both in the southwest disc, with the former showing some signs of simplification but the latter exhibiting very slow growth. Despite this, it remains a magnetically simple and stable region, with no notable flaring. The third region, AR2901 Hsx/alpha, in the northeast appears to be a small but stable and mature feature, situated amongst a small area of plage.

Solar Activity is forecast to be Very Low to Low, with a 60% chance of C-class flares, primarily from AR2900. There is a very slight, but above background, chance of an isolated M-class flare (5%).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16/17 X-ray Flux

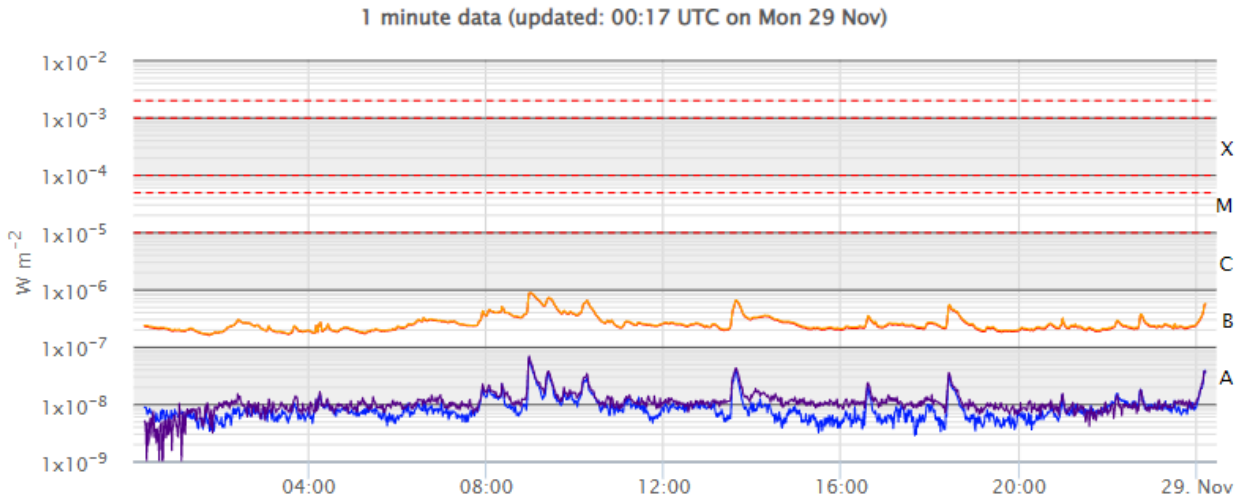

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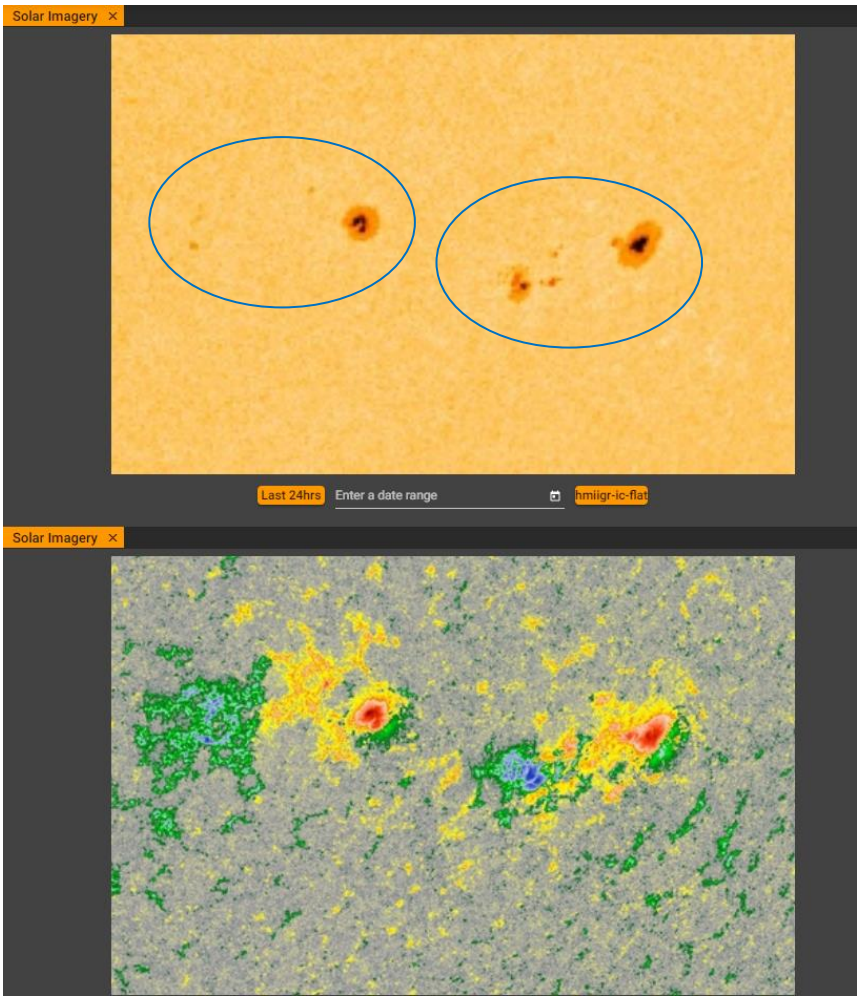
Figure 4: SDO Intensitygram (top) and magnetogram (bottom) or AR2898 (left) and AR28900 (right)



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is forecast to remain at background levels, with no solar radiation storms anticipated.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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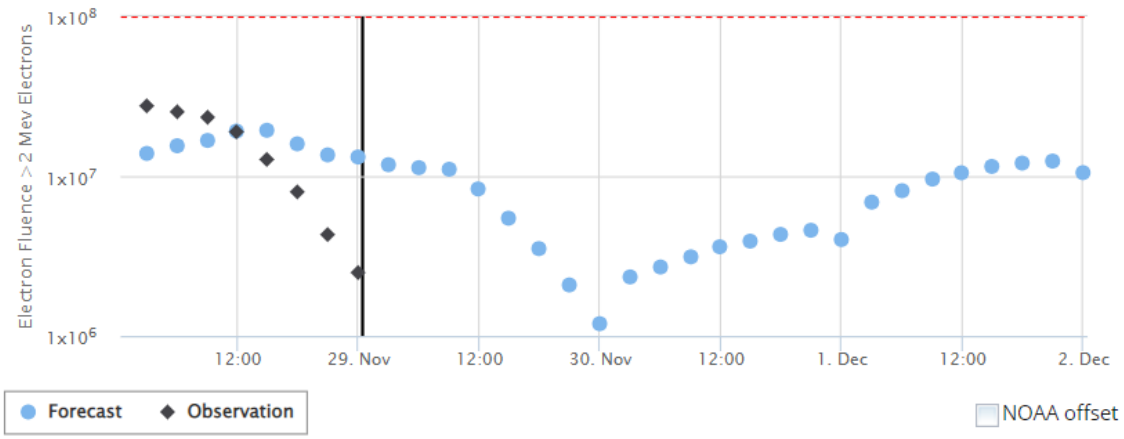
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO has been mainly background during the last 24 hours, and is expected to be at background to moderate levels through the period. The next main enhancement is likely to be from the fast wind of CH25 or CH26, potentially increasing levels to High on day 4 (2nd), however confidence is low. Other enhancements to the solar wind on days 1-2 are currently not expected to lead to high flux levels being observed.

With flux remaining below the High level until at least day 4, the associated 24 hour integrated fluence is expected to remain below the Active threshold, with only a slight chance of rising above at the end of the period (2nd). This is supported by REFM which maintains fluence levels at well below the Active threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron Fluence with REFM



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